AD 419319

SECOND QUARTERLY PROGRESS REPORT

CR-(SM-64)/E

Moderate Precision Glass Enclosed Crystal Units

1 July - 30 September 1962

64-5

Contract Number DA-3[illegible]-SC-[illegible]

Placed By

UNITED STATES ARMY SIGNAL SUPPLY AGENCY
PHILADELPHIA, PENNSYLVANIA

MIDLAND MANUFACTURING COMPANY, DIVISION
PACIFIC INDUSTRIES, INCORPORATED
3155 FIBERGLAS ROAD
KANSAS CITY 15, KANSAS

UNCLASSIFIED

CR-(XM-44)/U Moderate Precision Glass Enclosed Crystal Units

SECOND QUARTERLY PROGRESS REPORT COVERING PERIOD 1 JULY - 30 SEPTEMBER 1962

The object of this study is to establish capability to manufacture moderate precision crystal units in the HC-27/U (glass) crystal holder.

Contract Number DA-36-039-SC-86717
Signal Corps Specification SCS-120 (9 Nov. 1961)

Prepared by:

Howard E. Dillon

and

John G. Deininger

MIDLAND MANUFACTURING COMPANY

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ABSTRACT

Construction of glass-holder sealing equipment is under way.

Tentative quartz resonator designs have been partially evaluated, and appear to be satisfactory.

PURPOSE

This program is aimed at establishing a production source capable of mass producing a semi-precision quartz crystal unit in in an evacuated glass holder. The significance of glass and vacuum on long term reliability and aging characteristics has been proven in previous Signal Corps R & D. Contracts.

When attempting to manufacture a semi-precision crystal unit, several items must be considered and reappraised in the light of generally tighter performance tolerances. This reappraisal generally leads to tightening of manufacturing controls and tolerances Conventional methods of quartz orientation, sawing, dicing, dimensioning, and lapping will be used to obtain a suitable quartz plate. In order to obtain a satisfactory yield, "with a minimum of shrinkage without resorting to screening," a double diffraction X-ray will be used to select plates within one minute of arc. Tighter control at X-ray will necessitate tighter tolerances in the preliminary orientation and sawing operations

Finish lapping operations, etching, and cleaning processes will of necessity be reviewed and refined as necessary to produce a suitable quartz plate for proper adhesion and stability of the metal electrodes.

The mechanics of sealing the glass, without a frequency shift or other damaging after effects, will demand careful study and effort. The importance of the sealing operation is manifold: Acceptable units will be expected to give an excellent yield through final testing if proper care was exercised in various steps of fabrication. Unacceptable units either improper seals or failure to meet electrical specifications, will require destruction of the holder in order to salvage and reuse quartz plates. It is anticipated that meeting the frequency tolerance at the sealing operation will be the most serious problem to overcome.

NARRATIVE AND DATA

Work was continued during the second quarter of the project, on the construction of a sealing tool for HC-27/U holders, and on the evaluation of various quartz resonator designs. Neither task has yet been completed.

Construction of the single head sealing tool was delayed, in part, by several errors in the drawings for the base of the sealing chamber. Because of the need for rework in a shop outside of our plant, a delay of several weeks resulted. Inasmuch as we have never sealed the HC-27/U holder we feel it most important to eliminate the obvious areas of trouble in the beginning; also, very tight deminsional tolerances require more time than usual in the machining of the several parts of the fixutre. An in-plant model shop is nearing completion, and it is expected that machine work and assembly of tooling will progress more rapidly in the future.

An r-f power generator of 1.0 KVA capacity has been procured from Induction Heating Corporation, Brooklyn, New York, An induction coil, to be used for inducing the heating currents in the metal strip between the glass base and bulb parts of the crystal holder has been designed. A vacuum pump system, with associated valves and controls, has been assembled as part of the glass-sealing tool.

Several lots of overtone quartz resonators have been designed, fabricated, and partially tested. Since the glass-sealing tool has not been completed, the resonators have been mounted in nitrogen-filled HC-6/U holders with tab-clip supports. Measurements of resonant resistance and motional capacitance indicate that the Q requirements will be satisfied without difficulty.

In order to calculate the resonant resistance of the crystal resonators in a vacuum from a knowledge of their resistance in [illegible] nitrogen, reference was made to an analysis by Roberts. Interestingly, a minor error was discovered in the analysis, which, when corrected, gives more accurate formula for predicting the effect of atmospheric loading upon the resonant resistance. Robert's formula accounts for the viscous loading upon one side of the plate only, and the formula is corrected by multiplying the right hand side of the atmosphere resistance formula by two. The results of tests on fabricated resonators, together with design data, are given in Table I through V.

Some difficulty has been experienced in the finish-plating operation for used for sample resonators, and appears to have required more adequate electronic instrumentation. The method which was used to monitor the frequency of the crystal being plated involves the conversion to zero of the frequency of a special low-drive-level oscillator controlled by the crystal being plated. In accordance with conventional shop practice, a frequency meter is supposed to continuously monitor the difference between the frequency of the low-drive-level oscillator and that of a pre-adjusted standard-frequency oscillator. It appears that, in some cases, the frequency meter is responding to the second harmonic of the unfiltered difference frequency from the mixer. The finish-plating equipment has been modified, and the difficulty removed, by plating very slowly while monitoring the crystal frequency with an electronic digital frequency counter. A schematic diagram of the low-drive-level oscillator is shown in Figure 1.

The RFL TS-330/TSM adaptor has been installed in one of the test sets and indications are it will perform as expected. When the test se

Is used with crystal units requiring regular 3098B drive levels (adaptor switched out), the test set drive control must be turned nearly full on and the frequency goes upward, in some cases requiring switching band selector switch to next higher position.

There is also some indication of severe drift of frequency and drive level through an eight hour day. An investigation of these phenomenon revealed low mutual conductance in the 6AU6 tube which had no effect on performance before installation of the adapter.

Test results on some crystal units fabricated in the higher frequency ranges were unfavorable. Resistances were high and T-C curve turnover point was well below that specified in SCS 120. Additional units, with modifications, have been ordered from saw department. Midland maintains a rough blank inventory at lap, but in the case of the CR-(XM-44)/U, the high angle and thickness requirements are out of line with our general run of crystal units. A change in the orientation angle necessitates going to the saw department and starting with a new stone.

A complete bill of materials for the CR-(XM-44)/U was not specified by the contracting agency, and none has been established here as yet. The following parts have been procured for evaluation:

Bulb & Base, HC-27/U. 200 pcs. each from Phillips of Canada

Bulb & Base, HC-27/U 25 pcs. each from Masden Co., Inc.

Tab clips, Stainless steel. 500 pcs. from Kay Electronics

Isochemduct 3.5 Epoxy resin cement with #6 special epoxy hardener
(Sample quantity for evaluation)

Pyro-Ceram, #95 high temperature cement from Corning Glass Co.

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FOOTNOTES

*1. Roberts, E.A., Atmospheric Loading Effects on AT crystals. Semi-annual report, contract DA-36-SC-71061, Union Thermo-electric Corporation, 1 July to 24 December 1956, pp. 38-47.

CONCLUSIONS

Data collected on quartz resonator designs indicate the specification can be met. Greater difficulty, than what was at first expected, surrounds the construction of the sealing machine.

An estimated 5% of the overall progress has been accomplished in the second quarter.

PROGRAM FOR NEXT INTERVAL

Establish a sealing technique and test seals for conformance to SCS-120. If successful engineering samples will be made and submitted as per contract.

MAN-HOURS

Howard E. Dillon	400 hours
Edward M. Roper	50 hours
John G. Deininger	300 hours
Production line personnel	200 hours

Design and Performance Data 3rd Overtone Resonators

LOT NO. H2A 1

PLATE DIA. 0.550in ELECTRODE DIA 0.400in ANGLE 35° 24

CONTOUR 4 diopter Plano - convex BEVEL None

LOAD CAPACITANCE 50 pf

XTAL NO	RESONANT (Fr) FREQUENCY (mc)	ANTIRESONANT (Fa) FREQUENCY (mc)	RESONANT RESISTANCE (ohm)	Fa-Fr (cps)	STATIC CAPACITANCE (pf)
1	5.008885	5.008913	260	28	4.4
2	5.005123	5.005152	130	29	4.4
3	5.006650	5.006677	100	27	4.4
4	5.007137	5.007164	100	27	4.4
5	5.008607	5.008636	160	29	4.4
6	5.002445	5.002473	140	28	4.4
7	5.006768	5.006797	110	28	4.4
8	5.009080	5.009104	170	24	4.4
9	5.002328	5.002357	190	29	4.4
10	5.009483	5.009511	110	28	4.4
11	5.007076	5.007124	110	28	4.4
12	5.003250	5.003278	160	28	4.4
13	5.003760	5.003789	120	29	4.4
14	5.006757	5.006785	130	28	4.4
15	5.005922	5.005952	180	30	4.4
16	5.005800	5.005826	100	26	4.4
17	5.002479	5.002507	100	28	4.4
18	5.006088	5.006119	230	31	4.4
19	5.009363	5.009392	90	29	4.4

TABLE I

Design and Performance Data 3rd Overtone Resonators

LOT NO. M 2 A 3

PLATE DIA. 0.550 in ELECTRODE DIA. 0.400 in ANGLE 35° 25'

CONTOUR 12 Diopter Bi-convex BEVEL None

LOAD CAPACITANCE 50 pf

ITEM NO.	RESONANT (Fa) FREQUENCY (mc)	ANTIRESONANT (Fa) FREQUENCY (mc)	RESONANT RESISTANCE (ohm)	Fa - Fr (cps) Fa - FR	STATIC CAPACITANCE (pf)
1	7.014565	7.014710	100	145	5.5
2	7.007703	7.007848	110	145	5.5
3	7.007694	7.007839	120	145	5.5
4	7.015886	7.016032	120	146	5.5
5	7.012408	7.012559	100	151	5.5
6	7.010536	7.010704	180	168	5.5
7	7.013073	7.013220	140	147	5.5
8	7.018160	7.018315	100	155	5.5
9	7.009467	7.009614	100	147	5.5
10	7.013203	7.013348	80	145	5.5
11	7.018136	7.018290	90	154	5.5
12	7.016918	7.017070	70	152	5.5
13	7.015635	7.015788	120	153	5.5
14	7.015515	7.015669	100	154	5.5
15	7.012728	7.012878	80	150	5.5
16	7.019286	7.019431	140	145	5.5

TABLE II

Design and Performance Data - 3rd Overtone Resonators

LOT NO. M 2 A 2

PLATE DIA. 0.550in ELECTRODE DIA. 0.370 in ANGLE 35° 25'

CONTOUR 9 Diopter bi-convex BEVEL None

LOAD CAPACITANCE 50 PF

ITEM NO.	RESONANT (Fr) FREQUENCY (mc)	ANTIRESONANT (Fa) FREQUENCY (mc)	RESONANT RESISTANCE (ohm)	fa-fr (cps)	STATIC CAPACITANCE (pf)
1	10.082352	10,082652	30	300	6.9
2	10.087014	10.087307	43	293	6.85
3	10.080278	10.080552	40	274	6.85
4	10.078309	10.078580	30	271	6.7
5	10.075037	10.075320	40	283	6.9
6	10.078706	10.078986	35	280	6.85
7	10.081851	10.082136	50	285	6.85
8	10.068569	10.068837	19	268	6.7
9	10.082980	10.083257	30	277	6.7
10	10.068006	10.068285	27	279	6.9
11	10.090393	10.090674	24	281	6.85
12	10.057755	10.058025	31	270	6.8
13	10.0812214	10.081499	44	285	6.9
14	10.077651	10.077933	27	282	6.9
15	10.071003	10.071276	27	273	6.8
16	10.084564	10.084845	28	281	6.8
17	10.064856	10.065151	20	295	6.8

TABLE III

Design and Performance Data - 3rd Overtone Resonators

LOT NO. M 2 A 6

PLATE DIA. 0.448 in ELECTRODE DIA. 0.300 in ANGLE 35° 24' 25'

CONTOUR #6 Diopter bi-convex BEVEL None

LOAD CAPACITANCE 50 PF

ITEM NO. 1	RESONANT (fa) FREQUENCY (mc)	ANTIRESONANT (Fa) FREQUENCY (mc)	RESONANT RESISTANCE (ohm)	Fa-Fr (cps)	STATIC CAPACITANCE (pf)
1	15.073540	15.073935	28	395	6.2
2	15.043862	15.044224	20	362	6.2
3	15,021321	15,021728	22	407	6.3
4	15,036466	15,036852	1[illegible]	386	6.5
5	15.033574	15,033975	27	401	6.2
6	15.044994	15.045349	26	355	6.3
7	15.044468	15.044840	15	372	6.4
8	15.034928	15,035299	17	371	6.3
9	15.043974	15.044298	22	324	6.4
10	15.048367	15.048258	20	391	6.2
11	15.046990	15.042375	24	385	6.5
12	15.032071	15.032434	26	363	6.3
13	15.042538	15.042912	18	374	6.3
14	15.039127	15.039521	20	394	6.2
15	15.045223	15.045612	19	389	6.2
16	15.036352	15.036742	23	390	6.3
17	15.038250	15.038630	31	380	6.3

TABLE IV

Design and Performance Data - 3rd Overtone Resonators

LOT NO. M 2 A 7

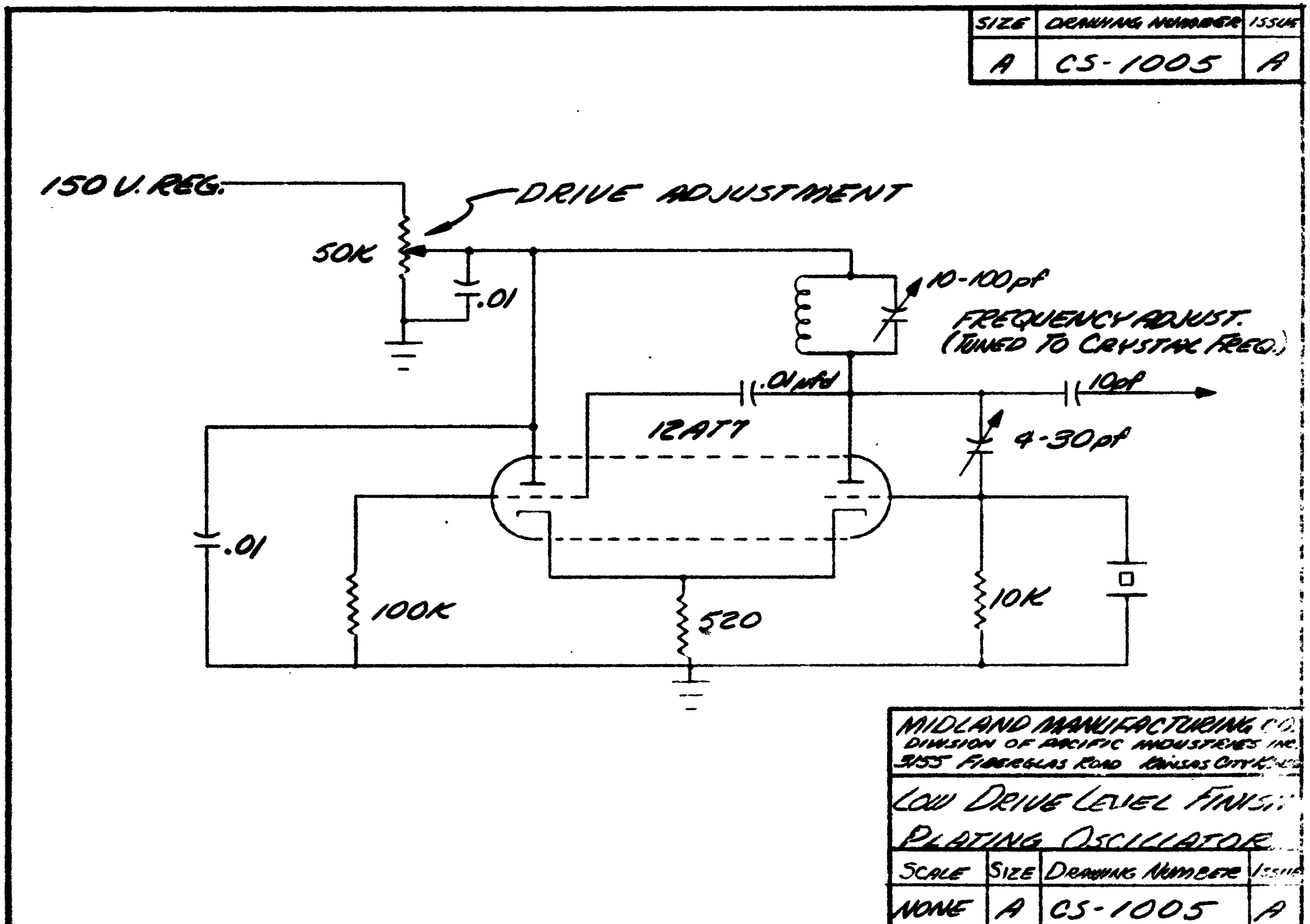
PLATE DIA. 0.448 in ELECTRODE DIA. 0.300 in ANGLE 35° 25' 26'

CONTOUR One Micron finish BEVEL None

LOAD CAPACITANCE 50 PF

ITEM NO.	RESONANT (Fa) FREQUENCY (mc)	ANTIRESONANT (Fa) FREQUENCY (mc)	RESONANT RESISTANCE (ohm)	FA-Fr (cps)	STATIC CAPACITANCE (pf)
1	19.935306	19.935845	19	539	8.1
2	19.940332	19.940902	15	570	8.2
3	19.963927	19.964522	11	595	8.3
4	19.948767	19.949352	14	590	8.1
5	19.934024	19.934620	13	546	8.3
6	19.967955	19.968564	10	609	8.2
[illegible]	19.950621	19.951167	13	546	8.3
8	19.961384	19.961953	19	569	8.2
9	19.951077	19.951691	11	609	8.2
10	19.919377	19.919846	24	469	8.1
11	19.936391	19.936974	14	583	8.1
12	19.970868	19.971416	15	548	8.2
13	19.945928	19.946465	13	537	8.1
14	19.975101	19.975698	24	597	8.3
15	19.926666	19.927222	14	556	8.2
16	19.938497	19.939055	18	558	8.3

TABLE V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DRAWING NUMBER
ISSUE
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A
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.01
10-100pf
FREQUENCY ADJUST.
(TUNED TO CRYSTAL FREQ.)
.01 µfd
10pf
12AT7
4-30pf
.01
100K
520
10K
MIDLAND MANUFACTURING CO.
DIVISION OF PACIFIC INDUSTRIES INC.
3155 FIBERGLAS ROAD KANSAS CITY K.
LOW DRIVE LEVEL FINISH
PLATING OSCILLATOR
SCALE
SIZE
DRAWING NUMBER
ISSUE
NONE
A
CS-1005
A

FIGURE 1.